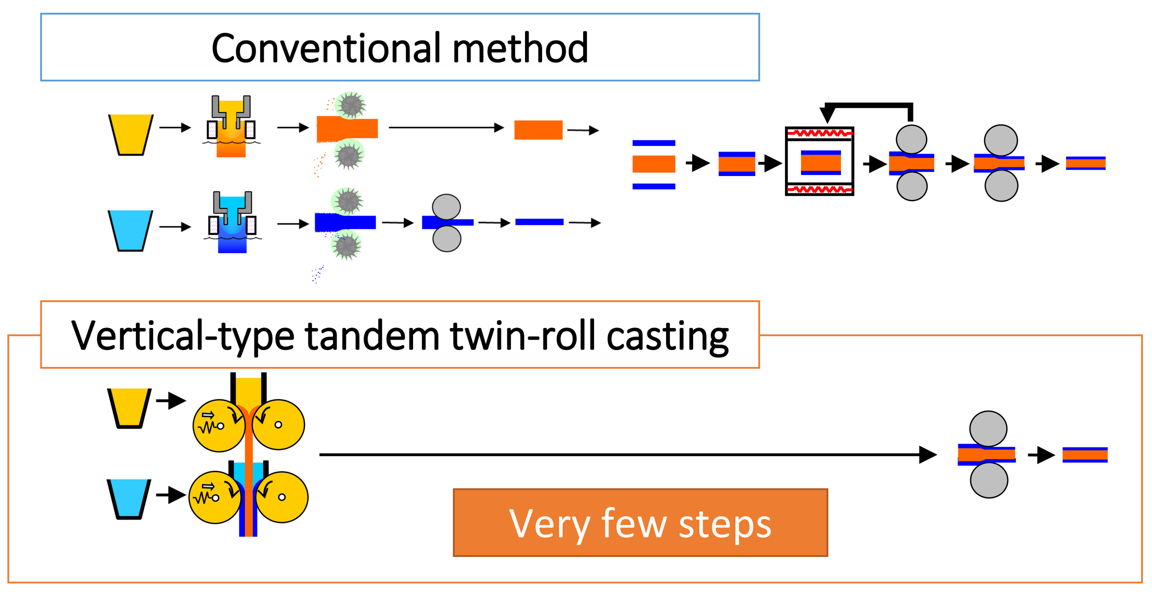
Tokyo Institute of Technology School of Materials and Chemical Technology Kumai-Muraishi laboratory

Solidification manner of Al-Cu / pure Al clad strips fabricated by vertical-type tandem twin-roll casting

Introduction

Back ground

■ Fabrication method of Aluminium alloy clad material [1) 2)]



■ Applications of Aluminium alloy clad material

- Automobile heat exchanger

http://www.uacj.co.jp/products/sheeting/brazing-sheet.htm

- Airplane body

http://www.jal.co.jp/aircraft/777er/img/800_600.jpg

Aim of this study

To investigate the interface between core / skin by using EPMA and EBSD to make the solidification manner clear

- Final goal : To make phenomena happening during casting clear to apply this method to other kinds of materials

Experimental method

Material

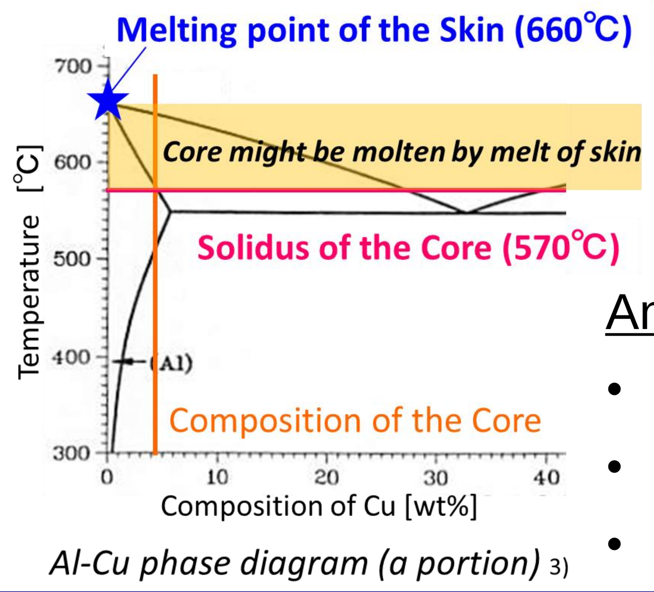
- Core: **Al-4.4wt%Cu**

(Solidus temperature: 570 ºC)

- Skin: **pure Al**

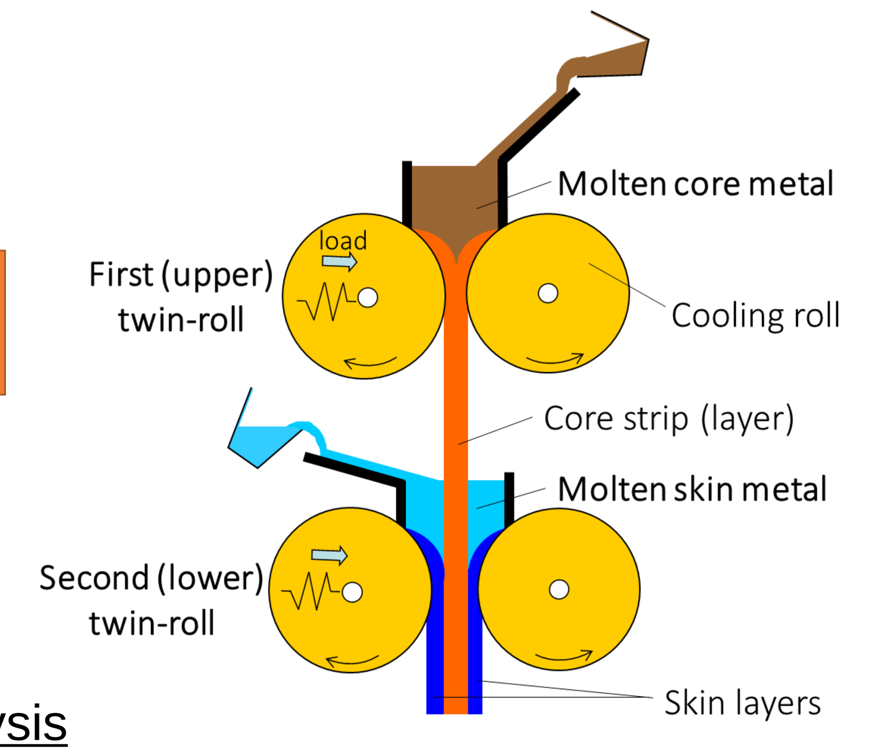
(Melting temperature: 660 ºC)

The core solidus is lower than the skin melting point



Al-Cu phase diagram (a portion) [3)]

Schematic diagram of vertical-type tandem twin-roll casting method

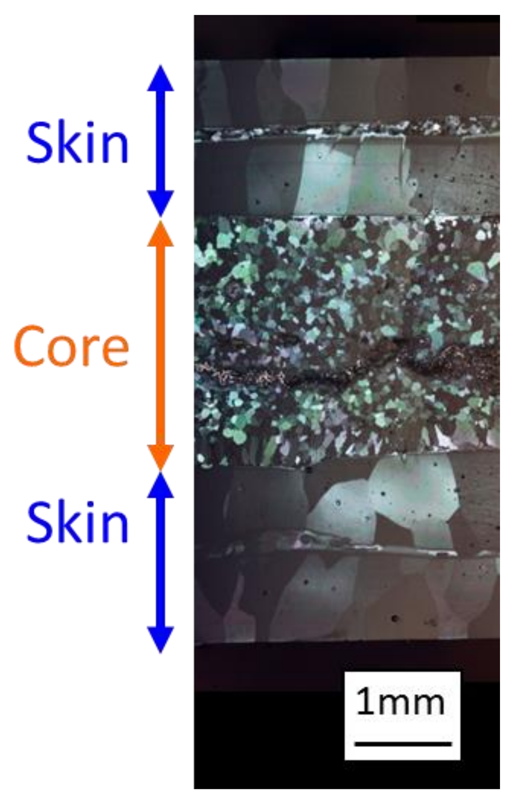


Analysis

- Microstructure observation (OM, SEM-BEI)
- EPMA (Elemental linear analysis)
- EBSD (Crystal grain orientation analysis)

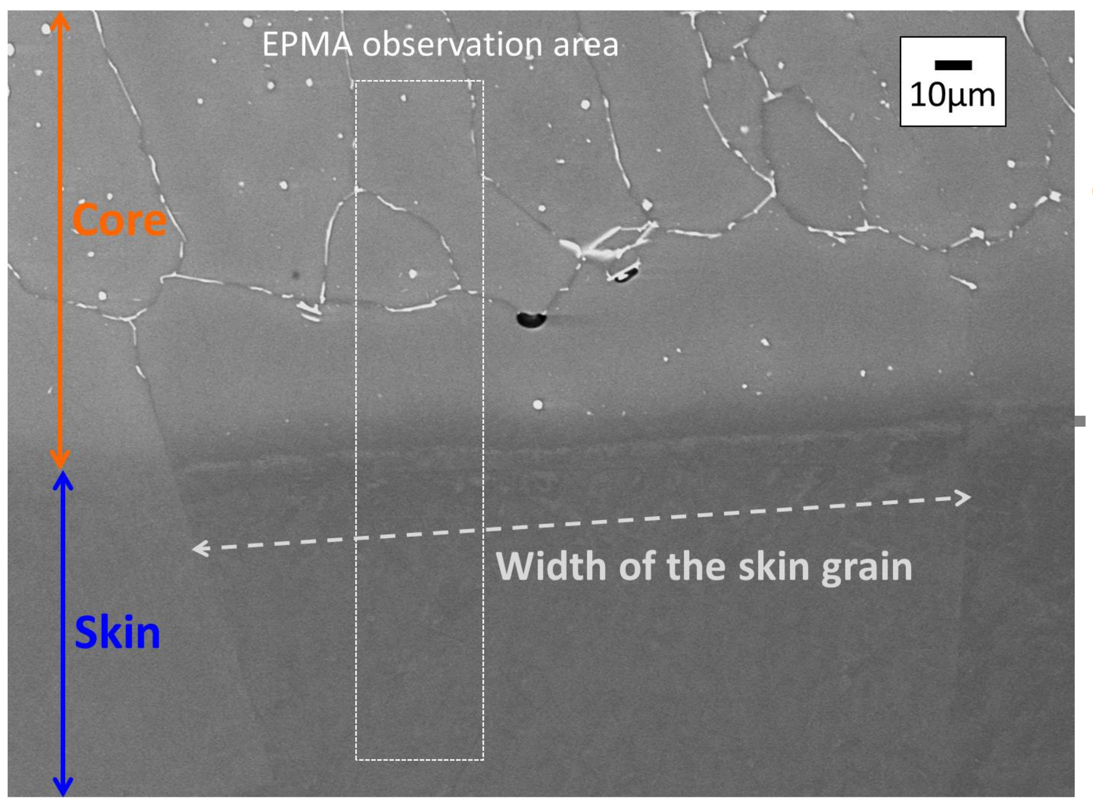
Results and discussion

OM observation (anodized)



- **Clear interface** between the core and the skin layers
- Skin grain size: quite large (some of them are over few hundreds μm)

SEM-BEI observation



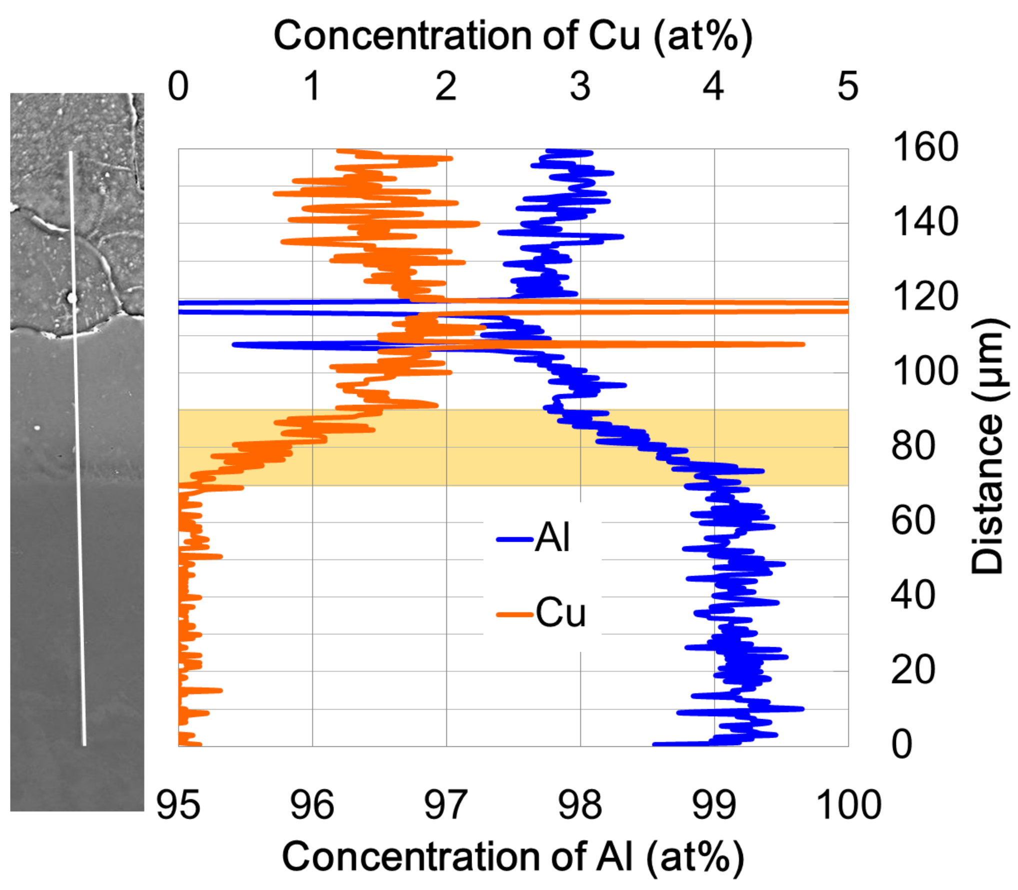
Core

- **grain boundaries** can be seen by distribution of white particles such as precipitates
- **no grain boundaries** can be seen *"the large width grain"*

Skin

- large grains whose widths are over 100μm can be seen (the same result as the OM observation)

EPMA elemental linear analysis

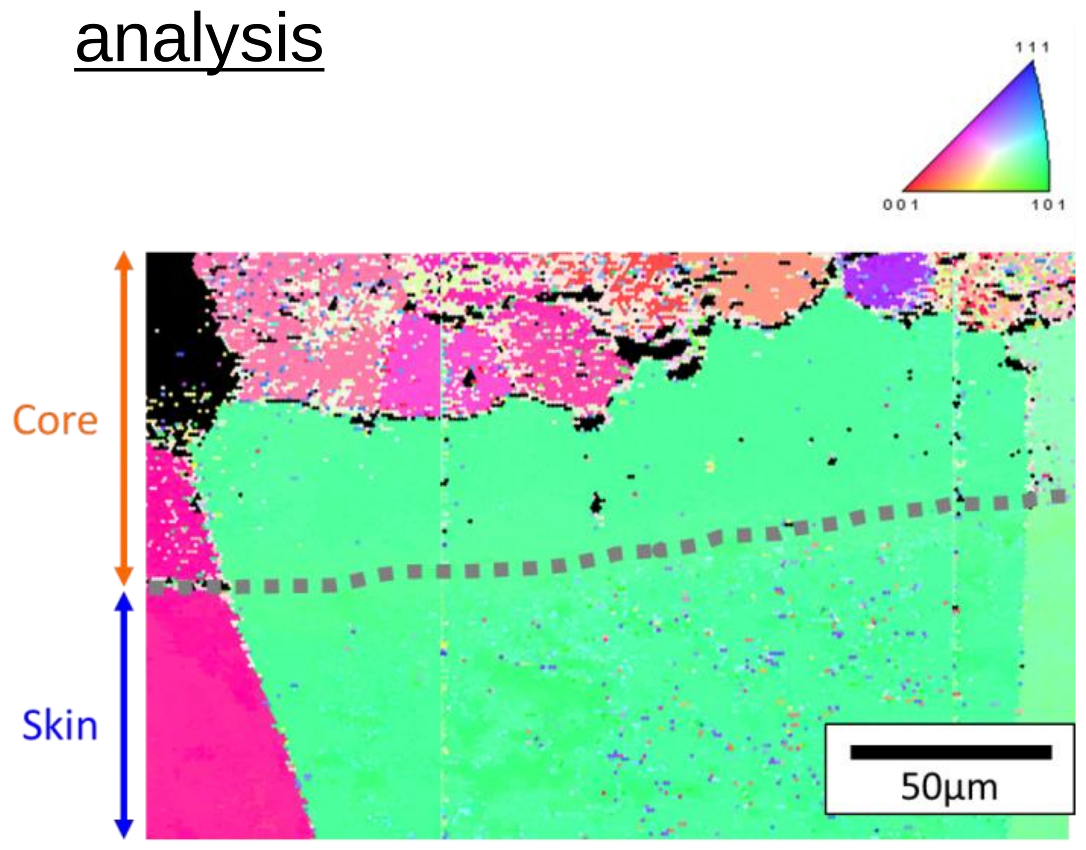


- **diffusion of Cu and Al** is observed
- the **diffusion length** across the interface is **about 20μm**

Too long diffusion length when only solid state diffusion is considered

Surface of the core is thought to be remolten during the casting

EBSD crystal grain orientation analysis



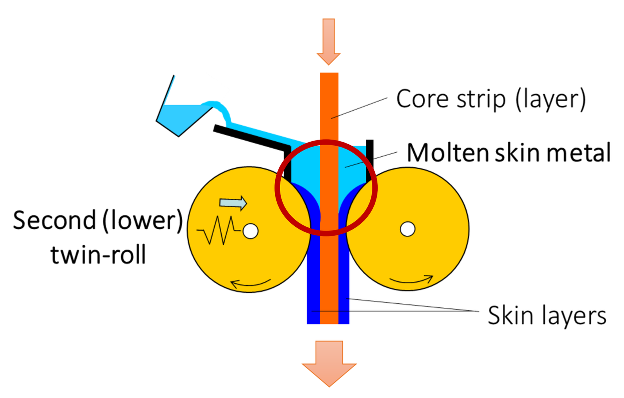
- ***"the large width grain"* has the same orientation as the skin grain next to**

■ **Core single layer strip**

- Near surface: **Fine chill grains**
- Clear columnar grains

Different from the core layer of the clad material

"the large width grain" is the **unique character** of the Al-Cu/pure Al clad strip fabricated by vertical-type tandem twin-roll casting



: the core is heated by the molten skin metal

Because the core layer is heated by the skin melt, re-melting and grain growth happen. As a result, *"the large width grain"* is formed near the surface of the core layer.

Summary and Future work

- Because of heat transfer from the skin melt to the core layer at the upper point of the 2nd roll gap, re-melting and grain growth occurred around surface of the core layer.
- Further discussion is needed about how solidification progress after the surface of the core is re-molten during the casting.

References

1) R.Nakamura, T.Yamabayashi, T.Haga, H.Watari, S.Kumai, Journal of Solid Mechanics and Materials Engineering, 5 (2011) 1029-1041.
2) R.Nakamura, T.Haga, S.Kumai, Proceedings of the 13th International Conference of Aluminium Alloys (ICAA13), (2012) 1463-1467.
3) Thaddeus B. Massalski, Binary Alloy Phase Diagrams Volume1, (1986) 142.